

# Detectors Outside the Cryostat

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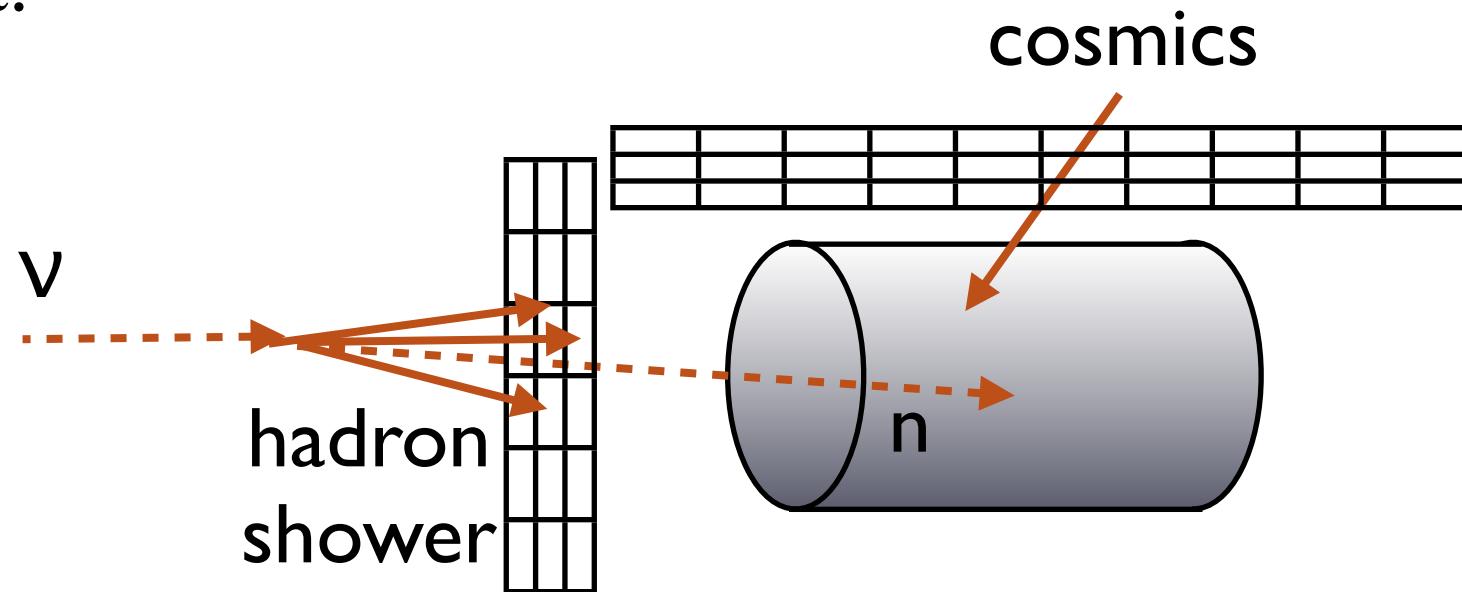
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# New Needs

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- In addition to reconstructing events in a TPC, many LAr experiments will want to identify backgrounds using auxiliary detectors outside the cryostat.
- Backgrounds due to cosmics and upstream dirt interactions can be measured with scintillator paddles around the cryostat.



# Add AuxDetGeo

- Describe a scintillator paddle, and useful functions to retrieve geometry and position. Assume: TGeoBBox.

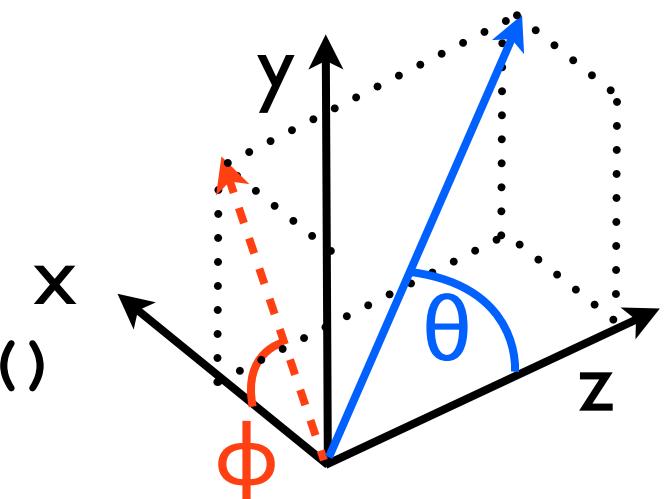
## World

**DetEnclosure** (**Geometry\_service.cc**)  
(**Geometry.h**)



# AuxDetGeo methods

- **void GetCenter(double \*xyz, double localz=0)**
  - get the center of the paddle into an array xyz
- **void GetNormalAngles(double \*phiTheta)**
  - get the global angles for the normal vector of the paddle (perpendicular to length and width, phi in xy-plane, theta measured from z-axis)
- **double Length() const**
  - get the paddle length by **TGeoBBox GetDX()**
- **double HalfWidth() const**
  - get half the paddle width by **TGeoBBox GetDY()**
- **double HalfHeight() const**
  - get half the paddle height by **TGeoBBox GetDZ()**
- **double DistanceToPoint(double \*xyz)**
  - return distance from xyz position to center of paddle



# AuxDetGeo methods

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## Standard coordinate transformations

- **void LocalToWorld(const double\* local, double\* world)**  
**const**
  - use **TGeoHMatrix** to transform paddle coordinates to world coordinates
- **void LocalToWorldVect(const double\* local, double\* world)**  
**const**
  - use **TGeoHMatrix** to transform paddle coordinates to world coordinates
- **void WorldToLocal(const double\* local, double\* world)**  
**const**
  - use **TGeoHMatrix** to transform world coordinates to paddle coordinates
- **void WorldToLocalVect(const double\* local, double\* world)**  
**const**
  - use **TGeoHMatrix** to transform world coordinates to paddle coordinates

# Add AuxDetReadout

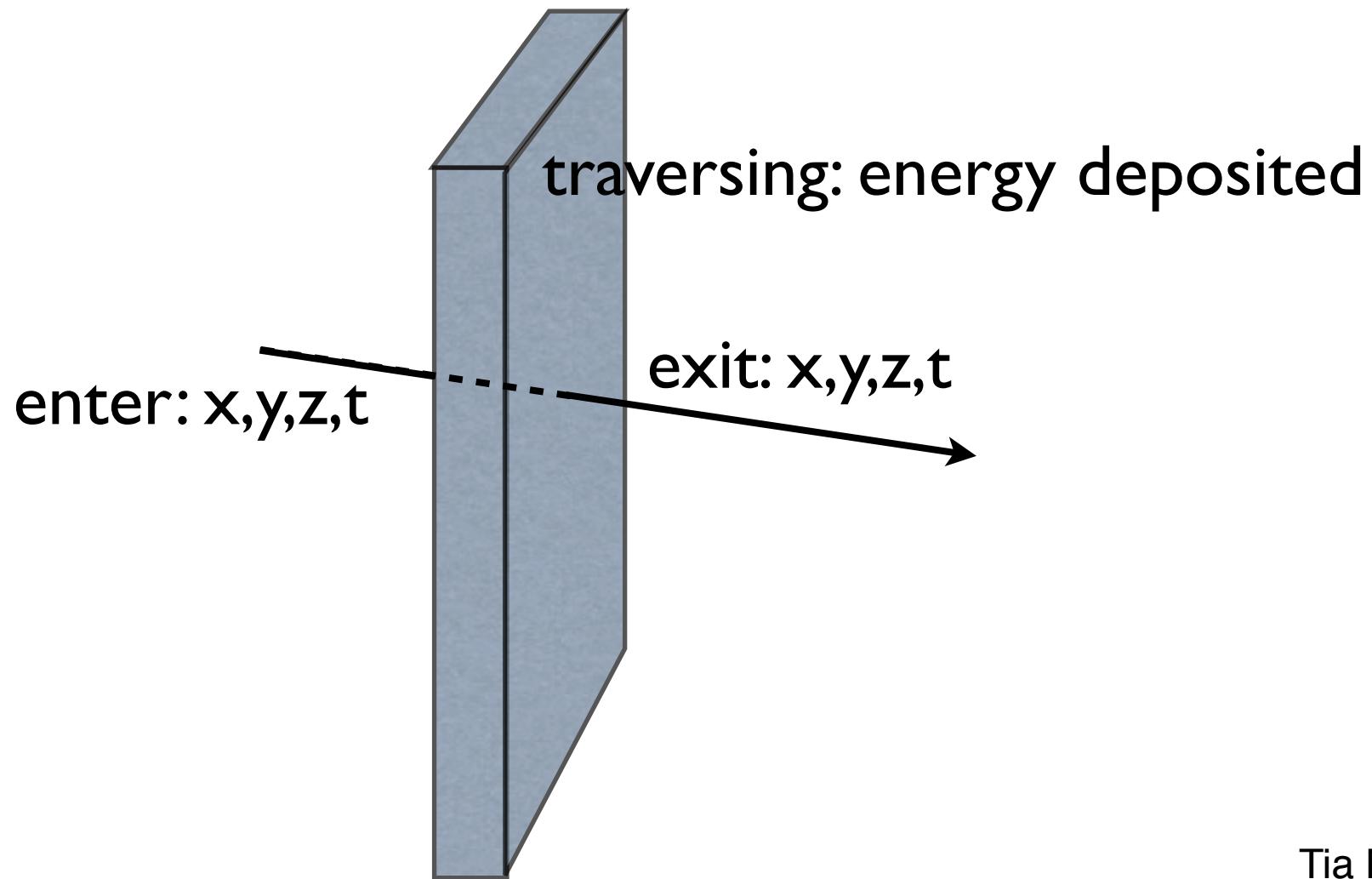
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- Define paddle volume as an active detector to save simulated particle information.
- Regular constructors/destructors/initializers
  - **virtual G4bool ProcessHits (G4Step\*, G4TouchableHistory\*)**
  - make a call to **SimAuxDetChannel**

# Add SimAuxDetChannel

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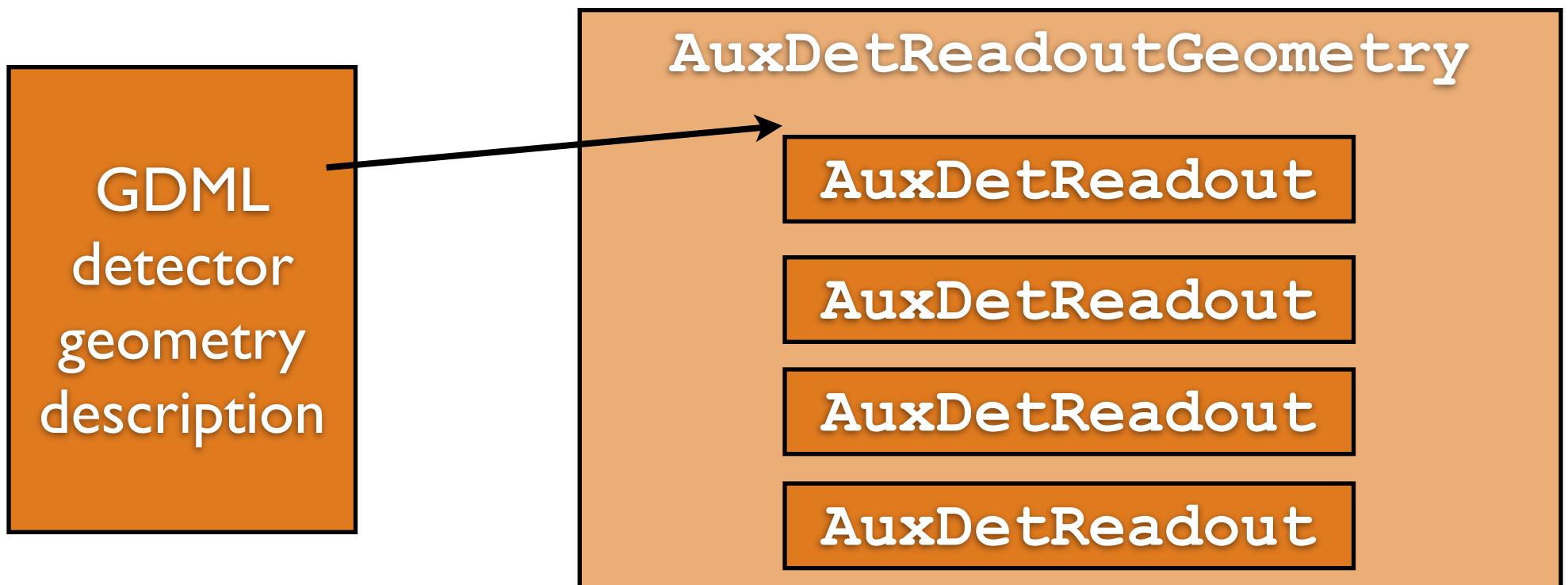
- Save particle trackID, energy deposited, enter location/time, exit location/time



# Add AuxDetReadoutGeometry

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- Grab the new auxiliary scintillator paddle detectors from the GDML file and make an instance of an **AuxDetReadout** object for each.



# Update Geometry.h

public:

- **NAuxDet ()**
  - returns the number of scintillator paddles outside of the cryostat.
- **std::vector<std::string> AuxDetVolName () const**
  - return names of the vol of auxiliary detectors from the GDM $\lambda$  file.
- Any others?

# Update Geometry.h

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private:

- **fAuxDets**-> vector of **AuxDetGeo** objects.
- **void MakeAuxDet(std::vector<const TGeoNode\*>& path, int depth);**
  - call **AuxDetGeo** constructor, push onto a local vector of **fAuxDets**, return pointers to detectors.
- **void FindAuxDet(std::vector<const TGeoNode\*>& path, int depth);**
  - return pointers to detectors.
  - if not found, call **MakeAuxDet**.

# Control for MC Generation

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- If needed, could add an option in a fcl file to include/exclude these auxiliary detectors in the MC generation.
  - May allow speedier generation depending on needs.

# Summary

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- Upcoming LAr experiments including MicroBooNE anticipate a need to describe active detectors outside of the cryostat.
- An auxiliary detector geometry and readout class are proposed to facilitate such additions.
- Comments welcome.